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TITLE: ELECTROMAGNETIC INDUCTION HEATING DEVICE

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ABSTRACT:

PURPOSE: To utilize a higher harmonic current produced at a current converter effectively for electric heating by connecting a tertiary coil of a power transformer with a resonance capacitor and a second load coil serially.

CONSTITUTION: A tertiary coil 20 is applied to each phase of a power transformer 12, and its value is selected so that a second resonance capacitor 21 and a second load coil 23 of its output make a resonance by higher harmonic waves. As a result, a resonance current flows through the second load coil 23, and a magnetomotive force is produced at the second load coil 23 by this

resonance current, so as a subject matter in the load coil 23 is heated, while the higher harmonic current is less likely to flow through the primary side of the power transformer 12. Troubles of a higher harmonic current are not produced on the power source side, and the subject matter can be heated effectively by the higher harmonic current supplied to the second load coil.

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⑫公開特許公報(A)　平2-117089

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審査請求　未請求　請求項の数 1　(全3頁)

⑭発明の名称　電磁誘導加熱装置

⑳特　願　昭63-271454

㉒出　願　昭63(1988)10月26日

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明細書

1. 発明の名称

電磁誘導加熱装置

2. 特許請求の範囲

交流電源を整流して直流電流を得たあと、当該直流電流をインバータによって高周波電流に変換して負荷コイルで共振させるようにした電磁誘導加熱装置において、前記交流電源側の変圧器に第3巻線を施すと共に、該第3巻線と直列に第2の共振コンデンサ及び第2の負荷コイルを直列に接続して直列共振させ、この共振電流によって被加工物を補助加熱するようにしたことを特徴とする電磁誘導加熱装置。

3. 発明の詳細な説明

(産業上の利用分野)

本発明は高周波によって例えば鍛造用金属棒などの被加工物を加熱するための電磁誘導加熱装置に関する。

(従来の技術)

従来、特開昭62-122089号公報には、第3図の如く電源変圧器(Z)を介して三相電源(A)に入力される交流電流を三相全波整流器(B)で整流すると共に、該整流電流を平滑コンデンサー(C)で平滑にして直流電流に変換し、さらに多数のトランジスタ(D)(D)…を並列に接続したインバータ素子及びバランサーとしての共振コンデンサー(E)に流して高周波電流に変換したあと、負荷コイル(F)に印加して共振を生じせしめ、電磁誘導作用により負荷コイル(F)内の磁性体である被加工物を加熱することが記載されている。

(発明が解決しようとする課題)

しかし前記の電力変換装置においては、三相交流電源(A)より入力した交流電流より直流電流を得るために整流作用を行うとき、コンデンサー(C)に充電電流を流すため、電源変圧器(Z)の二次側の各線の線電流は通常、第4図の如く歪んだ波形になる。この波形は正弦波とは異なったものであり、基本正弦波(例えば50HZ、60HZ)に多くの高周波が重畳したものである。このように三相電源(A)の各線に高周波電流が流れると、

電源系統のインピーダンスによる電圧降下、すなわち電圧の高調波による微小変動などの電源障害を生ずる恐れがある。

本発明は上記の点に鑑み、電源側に高調波電流を流さないで、電力変換装置に発生する高調波電流を電気加熱のために有効に利用するようにしたものである。

（課題を解決するための手段）

本発明は上記目的を達成するために、交流電源を整流して直流電流を得たあと、当該直流電流をインバータによって高周波電流に変換して負荷コイルで共振させるようにした電磁誘導加熱装置において、前記交流電源側の変圧器に第３巻線を施すと共に、該第３巻線と直列に第２の共振コンデンサ及び第２の負荷コイルを直列に接続して直列共振させ、この共振電流によって被加工物を補助加熱するように構成したものである。

（作用）

本発明は電源変圧器の各相に第３巻線を施し、その出力の第２の共振コンデンサ及び第２の負荷コイルが高調波により共振するように、その値を選定しているため、第２負荷コイルに共振電流が流れ、該共振電流によって第２負荷コイルに起磁力を生じさせるので、該負荷コイル内の被加工物を加熱する一方、前記の電源変圧器の一次側には高調波電流を流れにくくする作用を行う。

（実施例）

第１図に示す電力変換器(11)は、電源変圧器(12)を介して三相電源(13)から入力される交流電流を整流して直流電流に変換する整流器(14)及び平滑コンデンサー(15)を備えると共に、直流電流を高周波電流に変換するためのインバータ素子として多数のトランジスタ(16)(16)…を備えており、さらに共振コンデンサー(17)及び第１の負荷コイル(18)を接続し、前記の第１負荷コイル(18)において被加工物は加熱作用を受ける。

一方前記の電源変圧器(12)に３次巻線(20)を巻いてデルター接続すると共に、該３次巻線(20)におけるデルター接続の一端を開放し、該開放部に第２の共振コンデンサ(21)及び共振周波数を調整するためのインダクタ(22)並びに第２の負荷コイル(23)を直列に接続して共振回路を構成すると共に、第１の負荷コイル(18)と第２の負荷コイル(23)とを同軸で巻きつけている。

しかして、前記の電磁誘導加熱装置を動作させたとき、電源変圧器(12)の変圧２次巻線(24)に流れる電流は高調波を含有しているが、第３高調波は一次巻線に流れることなくデルター接続の３次巻線(20)を環流しようとする。特に第２の共振コンデンサ(21)の回路を第３高調波電流が流れるため、第２の負荷コイル(23)に起磁力が生じ電磁誘導作用により第２負荷コイル(23)の被加工物を加熱すると共に、第１負荷コイル(18)と共動して被加工物を加熱する。

第２図の実施例において、電力変換器(25)の内部の構造は第１図に示す電力変換器(11)と全く同じであり、三相電源(26)を介して前記電力変換器(25)に入力を行うと、変換された高調波電流が共振コンデンサ(27)を介して第１負荷コイル(28)に送られる点は、第１図においてすでに説明した通りである。当該実施例が第１図と異なる点は、電源変圧器(30)の３次巻線(31)(32)(33)を各相独立するように絶縁して開放接続すると共に、各相の巻線(31)(32)(33)をそれぞれ別々の回路(34)(35)(36)を介して３個の第２負荷コイル(37)(38)(39)に接続し、さらに各回路にそれぞれ第２の共振コンデンサー(41)(42)(43)及びインダクタ(44)(45)(46)を介設したもので、各第２負荷コイル(37)(38)(39)と第１負荷コイル(28)とが共動して被加工物を加熱する。

（効果）

本発明によれば電源変圧器の３次巻線に第２の共振コンデンサと第２負荷コイルとを直列に接続して、高調波による共振電流を流すため、電源側には高調波障害が生ずることなく、第２負荷コイルに供給される高調波電流により被加工物を有効に加熱することが可能な電磁誘導加熱装置を提供できる効果がある。

4. 図面の簡単な説明

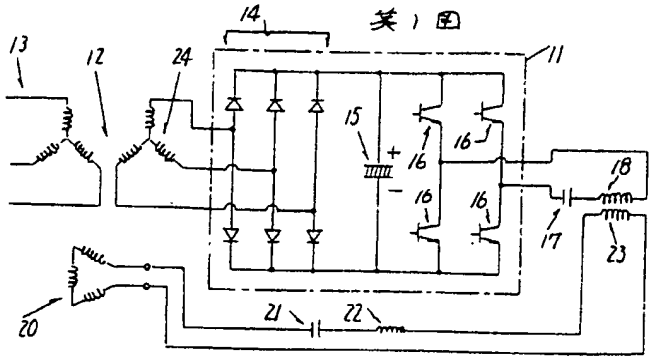
第１図は本発明の実施例を示す電気回路図、第

2図は他の実施例の説明図、第3図は従来の誘電加熱電源である電力変換装置の電気回路図、第4図は前図に起こる現象の説明図である。

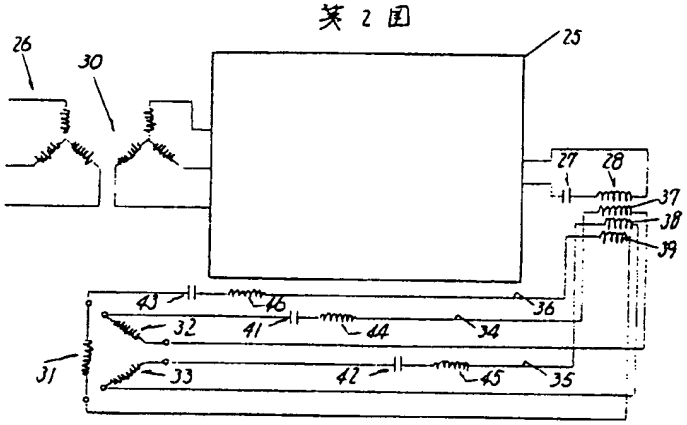
(12)…電源変圧器。 (14)…整流器、 (15)…平滑コンデンサ、 (16)…トランジスタ、 (17)…共振コンデンサ、 (18)…第1負荷コイル、 (20)…三次巻線、 (21)…第2の共振コンデンサ (23)…第2の負荷コイル、 (31,32,33)…3次巻線、 (37,38,39)…第2の負荷コイル、 (41,42,43)…第2の共振コンデンサ、 (44,45,46)…インダクタ。

出願人 北 嶋 廉 彦 外1名

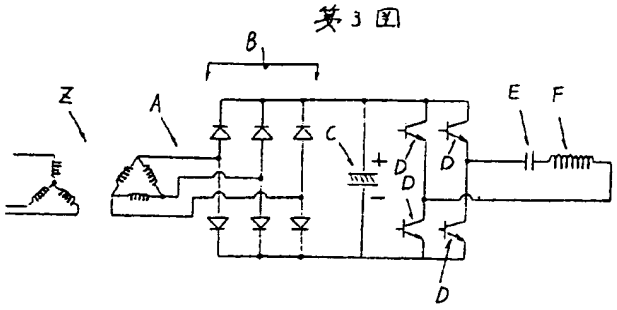
第1図



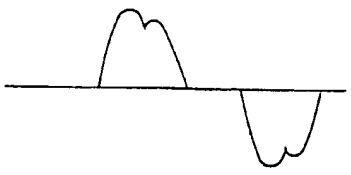
第2図



第3図



第4図



PTO 05-3135

Japanese Kokai Patent Application
No. Hei 2[1990]-117089

ELECTROMAGNETIC INDUCTION HEATING DEVICE

Tsuneo Watanabe

UNITED STATES PATENT AND TRADEMARK OFFICE
WASHINGTON, D.C. APRIL 2005
TRANSLATED BY THE RALPH MCELROY TRANSLATION COMPANY

JAPANESE PATENT OFFICE
PATENT JOURNAL (A)
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Publication Date:	May 1, 1990
No. of Claims:	1 (Total of 3 pages)
Examination Request:	Not requested

ELECTROMAGNETIC INDUCTION HEATING DEVICE
[Denji-yudo kanetsu sochi]

Inventor:	Tsuneo Watanabe
Applicants:	Yasuhiko Kitazumi and Uchino Co., Ltd.

[There are no amendments to this patent.]

Claim

1. An electromagnetic induction heating device characterized in that in an electromagnetic induction heating device in which after a DC current is obtained by rectifying an AC power supply, said DC current is converted into a high-frequency current using an inverter and resonated using a load coil, a transformer provided on the side of the aforementioned DC power is provided with a third coil, a second resonant capacitor and a second load coil are connected in series with said third coil to generate series resonance, and secondary heating is applied to a workpiece using said resonance current.

Detailed explanation of the invention

Industrial application field

The present invention pertains to an electromagnetic induction heating device used to heat a workpiece, for example, a metal rod for forging, using a high-frequency [wave].

Prior art

As shown in Figure 3, Japanese Kokai Patent Application No. Sho 62[1987]-122089 discloses that after an AC current input to a triphase power supply (A) is rectified by a triphase full-wave rectifier (B) via a power transformer (Z), and said rectified current is smoothened and converted into a DC current by a smoothing capacitor (C) and converted into a high-frequency current by an inverter element created by connecting many transistors (D), (D), ... in series and a resonant capacitor (E) serving as a balancer, it is applied to a load coil (f) to make it resonate in order to heat a workpiece as a magnetic material inside of the load coil (f) by means of an electromagnetic induction function.

Problem to be solved by the invention

However, in the aforementioned power-conversion device, because a charging current is applied to the capacitor (C) during the rectification function in order to obtain the DC current from the AC current input from the triphase AC power supply (A), line current of each line on the secondary side of the power transformer (Z) usually takes a distorted waveform as shown in Figure 4. Said waveform is different from a sine wave in that many frequencies are superposed on a base sine wave (for example, 50 Hz, 60 Hz). As such, when a high-frequency current flows into each line of the triphase power supply (A), there is the risk that the voltage drops due to the impedance of the power supply system, that is, a power supply problem due to a minute change caused by the high frequency of the voltage. In the light of the aforementioned point, in the present invention, a high-frequency current is utilized for effective electric heating instead of letting the high-frequency current flow to the power supply's side.

Means to solve the problem

In order to achieve the aforementioned purpose, the present invention is configured such that in an electromagnetic induction heating device in which after a DC current is obtained by rectifying an AC power supply, said DC current is converted into a high-frequency current using an inverter and resonated using a load coil, a transformer provided on the side of the aforementioned DC power is provided with a third coil, a second resonant capacitor and a second load coil are connected in series with said third coil to generate series resonance, and secondary heating is applied to a workpiece using said resonance current.

Function

In the present invention, because the third coil is provided for each phase of the power transformer, and its value is selected such that the second resonant capacitor and the second load coil serving as its output is resonated by a higher harmonic wave, a magnetomotive force is generated at the second load coil by said resonance current as the resonance current flows into the second load coil, the workpiece inside of said load coil is heated, and it is made unlikely for the higher harmonic current to flow to the primary side of the aforementioned power transformer at the same time.

Application examples

The power transformer (11) shown in Figure 1 is equipped with a rectifier (14) which rectifies an AC current input from a triphase power supply (13) via a power transformer (12) in order to convert it into a DC current and a smoothing capacitor (15) along with many transistors (16), (16), ... serving as an inverter element for converting a DC current into a high-frequency current; and a resonant capacitor (17) and a first load coil (18) are connected to it in order to heat a workpiece at the aforementioned first load coil (18).

On the other hand, a tertiary coil (20) is wound around the power transformer (12) so as to establish a delta connection, and one end of the delta connection of the tertiary coil (20) is opened up; a second resonant capacitor (21), an inductor (22) for adjusting the resonance frequency, and a second load coil (23) are connected in series so as to configure a resonant circuit at said opened part; and the first load coil (18) and the second load coil (23) are wound coaxially.

As such, when the aforementioned electromagnetic inductance heating device is activated, while a current which flows in a secondary voltage-transformation coil (24) of the power transformer (12) contains a higher harmonic wave, a third higher harmonic wave tries to circulate in the delta-connected tertiary coil (20) without flowing into the primary coil. In particular, because a third higher harmonic current flows in the second resonant capacitor (21), a magnetomotive force is generated at the second load coil (23) so as to heat the workpiece at the second load coil (23) using the electromagnetic induction function in addition to the heating of the workpiece at the first load coil (18).

In the case of the application example shown in Figure 2, internal structure of its power transformer (25) is exactly the same as that of the power transformer (11) shown in Figure 1. The point that when an input is made to the aforementioned power transformer (25) via a triphase power supply (26), the converted higher harmonic current is supplied to a first load coil (28) via a resonant capacitor (27) is identical to that already explained in reference to Figure 1. The present application example is different from Figure 1 in that tertiary coils (31), (32), and (33) of a power

transformer (30) are connected open-ended to the respective phases independently while they are insulated from each other; the coils (31), (32), and (33) of the respective phases are connected to three second-load coils (37), (38), and (39) via separate circuits (34), (35), and (36); and the circuits are provided with second resonant capacitors (41), (42), and (43) and inductors (44), (45), and (46), respectively; whereby, the respective second load coils (37), (38), and (39) and the first load coil (28) work together to heat the workpiece.

Effect

Because the second resonant capacitor and the second load coil are connected in series with the tertiary coil of the power transformer so as to let the resonance current generated by the higher harmonic wave flow, the present invention offers an effect that an electromagnetic induction heating device capable of heating a workpiece effectively using a higher harmonic supplied to its second load coil, without causing any problems related to the higher harmonic wave, occurs on its power supply's side.

Brief description of the figures

Figure 1 is an electrical circuit diagram showing an application example of the present invention. Figure 2 is a diagram for explaining another application example. Figure 3 is an electrical circuit diagram of a power transformer used as a conventional inductance heating device. Figure 4 is a diagram for explaining phenomena which take place in the figure given above.

12	Power transformer
14	Rectifier
15	Smoothing capacitor
16	Transistor
17	Resonant capacitor
18	First load coil
20	Tertiary coil
21	Second resonant capacitor
23	Second load coil
31, 32, 33	Tertiary coil
37, 38, 39	Second load coil
41, 42, 43	Second resonant capacitor
44, 45, 46	Inductor

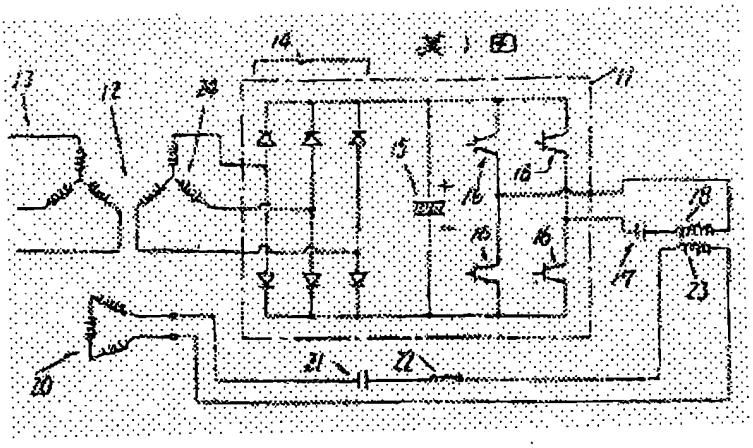

Figure 1

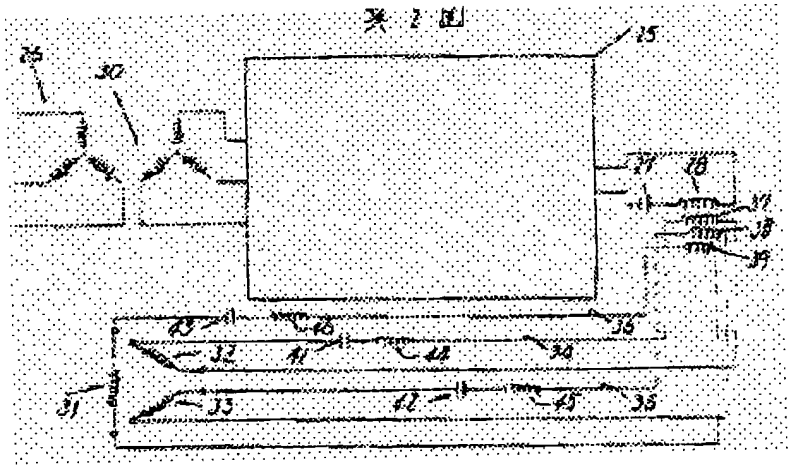

Figure 2

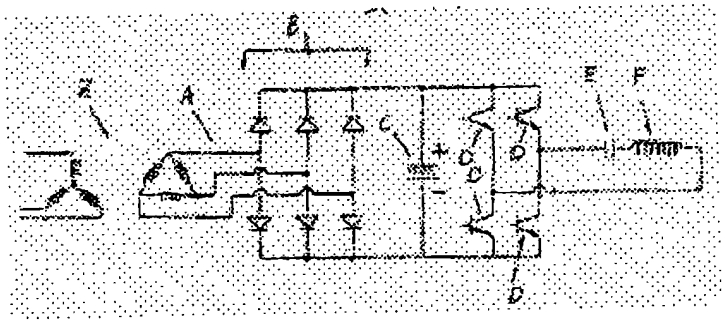

Figure 3

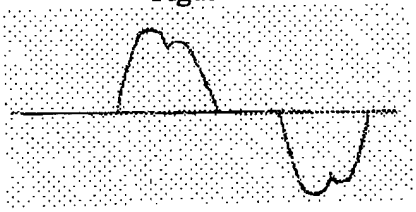

Figure 4